It is always best to get the actual shape designation from the suppliers. The two numbers after the shape designation (W, M) provide (1) the overall depth of the beam section and (2) the weight of the beam itself in pounds per lineal foot.

So a beam designated as a W 8 x 15 has a W shape with relatively wide flanges, a depth of 8 inches and weighs 15 pounds per lineal foot.

Question: Table 21.22-A1 gives sizes for beams when conventional framing is used. Table 21.22-A2 gives sizes of wood beams when truss roofs are used. Are there any tables that can be used for steel girders and beams when using truss roofs?

Answer: The correct size of a steel beam can be obtained through use of the Steel Construction Manual published by the American Institute of Steel Construction, Inc. This is the same organization that publishes the standard as adopted in s. Comm 20.24(2). This manual contains tables covering different sizes and shapes of steel beams and specifies the maximum load the beam can carry for a certain span. Table A of the following commentary section (21.22(3)) can be used to determine the actual load on the beam. In order to determine the total load on the beam, the actual load on the beam in pounds per lineal inch as calculated by Table A must be multiplied by the number of inches between the supports. The table found in Chapter 2 of the Steel Construction Manual can then be used by selecting a beam and then comparing the actual load on the beam calculated with the maximum allowable load of the beam. There are also structural software programs that may be used.

21.22(3) Wood Girder and Beam Design

The beam design tables as given in the Uniform Dwelling Code may be used for the design or analysis of simple span timber beams and headers with uniformly distributed loads.

The structural analysis for simple beams and headers are based on the following formulas:

BENDING

$M = \frac{w(l)^2}{8}$, $S = \frac{(12)\,M}{F_b}$, $F_b = \frac{(12)\,M}{S}$. (See Note A)

HORIZONTAL SHEAR

$R_v = \frac{w(l)}{2}$, $F_v = \frac{3(R_v)}{2(b)(d)}$

DEFLECTION "Delta" $= \frac{5(w)\,(l)^4}{384\,(E)\,(I)\,(1728)}$ (See Note B)

w = uniform load per length in pounds per linear foot (See Note C)
ℓ = length of beam between supporting members in feet
b = width of rectangular member (actual not nominal) in inches
d = depth of rectangular member (actual not nominal) in inches
S = section modulus of lumber in inches^3 (See Note D)
M = bending moment in foot-pounds
E = modulus of elasticity of lumber in psi (See Note E)
I = moment of inertia in inches^4 (See Note D)
F = allowable unit stress for extreme fiber in psi (See Note E)
F_v = allowable unit horizontal shear in psi (See Note E)
R_v = vertical reaction in pounds
T = tributary width in feet
"Delta" = deflection in inches (See Note F)

NOTE A – The number 12 in the numerator is used to convert M from foot-pounds to inch-pounds.

NOTE B - The number 1728 in the denominator is used to convert Delta from feet to inches.

NOTE C - The uniform load pounds per linear foot on a beam is calculated from the live loads (LL) and dead loads (DL) in pounds per square foot (s. Comm 21.02) and tributary load in feet (T) carried by the beam or header. The formula is: w = (DL + LL) (T) (See example below)

If more than one level is supported by beam or header, add the loads contributed by each ceiling, floor, and roof system supported to obtain the total uniform load per length on the beam. (See following diagram.)

NOTE D - The National Design Specification for Wood Construction, Appendix M gives the value for (S) and (I) for structural lumber. If built up beams and headers are used, the (S) and (I) for each member can be added together if of the same depth for rectangular members:

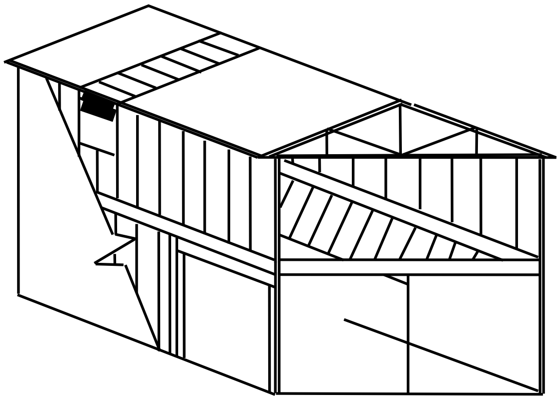
$$S = \frac{(b)\,(d)^2}{6} \quad \& \quad I = \frac{(b)\,(d)^3}{12}$$

NOTE E - F_b, F_v and E for various wood species can be obtained from Table 4A in the Design Value for Wood Construction Supplement to the National Design Specification for Wood Construction. The values for F_b, F_v & E (allowable) for the wood species must exceed the calculated f_b, f_v & E values (actual).

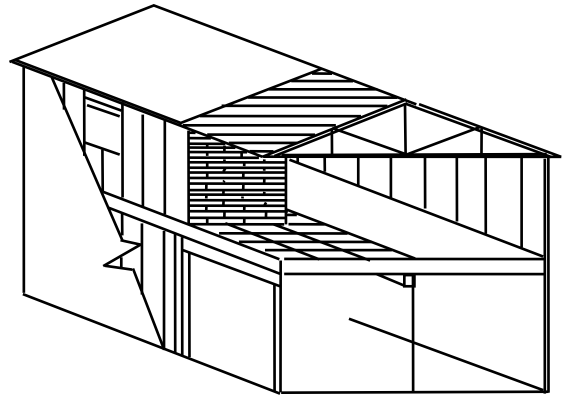
NOTE F - Deflection "Delta" should be limited to $(\ell)/240$ to reduce plaster cracking, objectionable springiness, and stresses on mechanical systems.

Examples of Tributary Areas:

Example 1 – Center Floor Beam

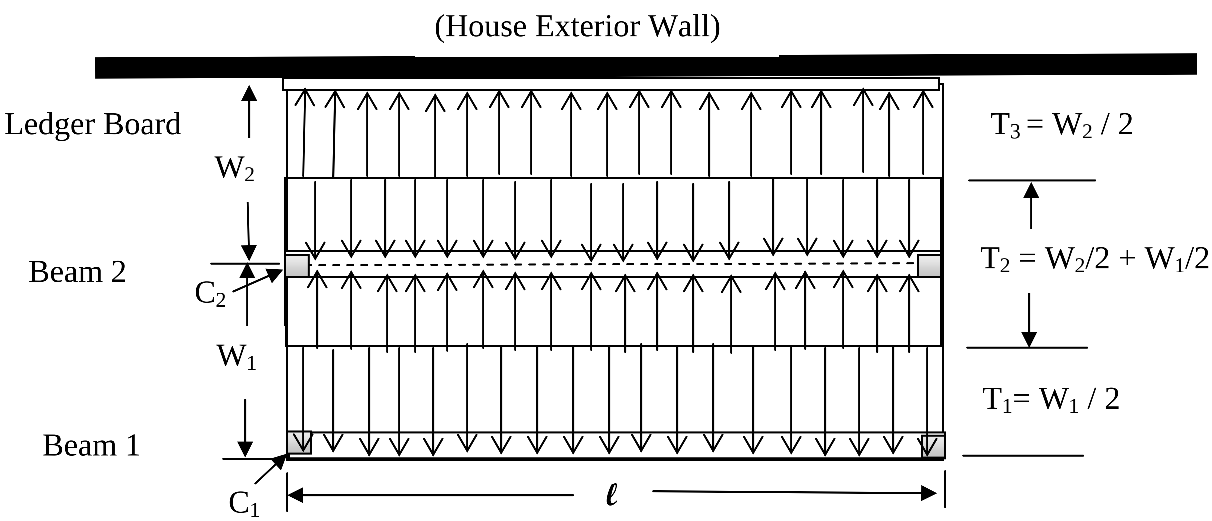


Supported joist length equals ½ the sum of the joist plus ½ the required bearing area called for in the code or truss spans on both sides of beam or header

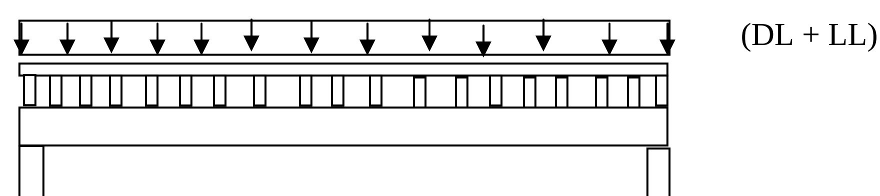


When the beam or header supports more than one structural system, the loads of each system are added.

Example 2 – Attached Exterior Deck



Deck Plan View



Cross – Section @ Center Beam

Example Calculations for Deck:

$w_{Beam\ 1} = (DL + LL)\ (T_1)$

R_v of Column C1 = $(w_{Beam\ 1})\ (\ell/2)$

$w_{Beam\ 2} = (DL + LL)\ (T_2)$

R_v of Column C2 = $(w_{Beam\ 2})\ (\ell/2)$

$w_{Ledger} = (DL + LL)\ (T_3)$

The following table may be used to size beams or headers. Table A provides the actual loads per inch on the member for various loading situations.

TABLE A Designed to give load (w) on a beam or header for various roof, ceiling and floor systems in pounds per lineal inch. Includes dead and live loads. If multiple loads are supported by the beam or header, then add the loads together from the applicable columns.

Supported Member Length in Feet*	(w)** Roof Zone 1	(w)** Roof Zone 2	(w) Ceiling Truss No Storage	(w) Ceiling Joist No Storage	(w) Ceiling Joist With Storage	(w) Floor: Per System
4	15	13	3	7	10	17
5	19	15	4	9	13	21
6	22	18	5	10	15	25
7	26	21	6	12	18	30
8	31	25	7	14	21	35
9	34	27	8	16	24	39
10	38	30	9	18	26	43
11	41	34	10	19	29	47
12	44	37	11	21	31	51
13	49	40	12	23	33	56
14	53	42	13	24	37	60
15	56	45	14	26	39	64
16	60	48	15	28	42	69
17	64	51	16	29	44	73
18	66	53	17	31	46	76

*See previous page for diagrams. Note that you may need to use different lines of this table for a beam or header that supports multiple systems of different supported member length.

**When there is a roof overhang, its length must be added to the supported member length.

Beam or Header Actual Load = ROOF (w) + CEILING (w) + FLOOR (w)

[Errata to 2011 UDC commentary]
9/6/11

Bearing of floor systems beams & girders [per Comm 21.22(4)(a)2.] or engineered wood products [per Comm 21.22(4)(b)] should be considered to have the load path [from Comm 21.02(1) requirement] followed beyond just the bearing point sizing for adequate load transfer, thus such beams may require additional wall studs directly below them all the way to the foundation below. If such supports have a header in them, typically separate structural analysis must be provided to properly size this header and those supporting jamb columns.

<u>21.22(4) Floor Joist Tails</u>

Question: Why can't the tail ends of joists overlap by more than the depth of a floor joist?

Answer: The reason for the requirement is to prevent potential subfloor uplift from the tail end reaction to the deflection of the joist span. This could be more of a problem at the center beam of a house in which the clear span roof trusses are used and there is no bearing wall resting on the floor joist tail ends.

Question: Can wood shims be used under a steel beam or under a steel column for minor dimensional adjustments? What about pressure treated lumber?

Answer: Maybe, but not likely, since the shim material used would need a compressive strength equal to or greater than the loads imposed by the typically highly loaded steel members. If structural calculations are lacking on this point, then steel shims would be required.

Holes & Notches in Sawn Joists and Rafters (D = Actual Member Depth)			
Member Size	Maximum Hole Diameter or Notch Length = D/3	Maximum Edge-Hole Diameter or Notch Depth (except at ends) = D/6	Maximum End Notch = D/4
2x6	1-3/4"	7/8"	1-3/8"
2x8	2-3/8"	1-1/4"	1-7/8"
2x10	3"	1-1/2"	2-3/8"
2x12	3-3/4"	1-7/8"	2-7/8'